International Journal of Electronics,
Communication & Instrumentation Engineering
Research and Development (IJECIERD)
ISSN(P): 2249-684X; ISSN(E): 2249-7951
Vol. 4, Issue 3, Jun 2014, 73-78

COMPARISON BETWEEN SPECTRUM SENSING IN COGNITIVE RADIO SYSTEMS

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ABSTRACT

Nowadays spectrum allocation could be a large problematic space for the wireless communication. Here, for the unauthorized users to use the licenced spectrum, unused frequency bands known as white areas have to be compelled to be detected. Cognitive radio will this task by dynamic spectrum access. This needs intelligent spectrum sensing techniques. To account for spectrum scarceness drawback and spectrum underutilization the cognitive radio comprehensive of spectrum sensing has been incorporated. One among the foremost vital factors of spectrum sensing for cognitive radio network is sensing accuracy. There are several spectrum sensing strategies are offered. Among that matched filter methodology and cyclostationary feature based mostly methodology performances are being compared underneath high noise and conjointly the performance of the system is being compared underneath numerous noise models as AWGN, Rician and Rayleigh to supply the simples spectrum sensing results.

KEYWORDS: Spectrum Sensing, Matched Filter Detection, Cyclostationary Feature Based Detection, Cognitive Radio

INTRODUCTION

Cognitive Radio

Cognitive Radio (CR) could be a style of wireless communication that a transceiver will showing intelligence and observe which communication channels are in use and which aren't, and instantly get in vacant channels whereas avoiding occupied ones. This optimizes the employment of accessible Radio-Frequency (RF) spectrum whereas minimizing interference to different users. This method is additionally called dynamic spectrum management. Figure 1 shows that the cognitive radio senses the spectrum, then analyze the channels within the spectrum that which are the used and unused of it, then manage those unused channels by fixing it to use for the acceptable users in line with their needs and eventually adapt those analyzed unused channels to the purported users. These all done by learning the radio atmosphere at the same time which works on like cycle so it's referred to as as Cognitive Radio Cycle. In its most simple kind, cognitive radio could be a hybrid technology involving Software Defined Radio (SDR) as applied to unfold spectrum communications that is employed for the reconfigurability of the functions within the Cognitive Radio.

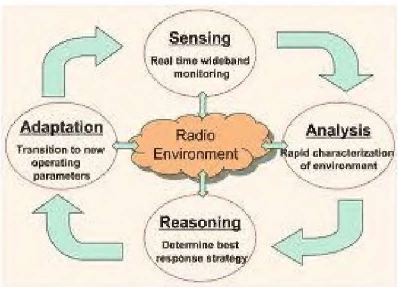

Figure 1: Cognitive Radio Cycle

Non Cooperative Sensing

In non cooperative sensing we've got to search out the first transmitters that are transmitting at any given time by victimization native measurements and native observations. The hypothesis for detection at time t are often delineated as

$$x(t) = \begin{cases} n(t), H0 \\ h \times s(t) + n(t), H1 \end{cases}$$

where x(t) is that the received signal of an unauthorised user, s(t) is that the transmitted signal of the authorized user, n(t) is that the noise like Additive White Gaussian Noise (AWGN) or Rayleigh fading channel, and h is that the channel gain. Here, H0 and H1 are outlined because the hypotheses of not having an indication from a authorized user within the target waveband, severally. Cognitive radio (CR) users can sight the presence or absence of users by victimization any of the spectrum sensing techniques like Energy detection, Matched filter detection or Cyclostationary feature detection.

PROPOSED SYSTEM

Matched Filter Detection

A matched filter (MF) may be a linear filter designed to maximize the signal to noise ratio for a given input. Once secondary user contains a priori data of primary user signal, matched filter detection is applied. Matched filter operation is like correlation within which the unknown signal is convolved with the filter whose impulse response is that the mirror and time shifted version of a reference signal. The operation of matched filter detection is expressed as

$$Y[n] = \sum_{k=-\infty}^{\infty} h[n-k]x[k]$$

where 'x' is that the unknown signal (vector) and is convolved with the 'h', the impulse response of matched filter that's matched to the reference signal for maximising the SNR. Detection by victimization matched filter is helpful solely in cases wherever the knowledge from the first users is thought to the cognitive radio users as shown in Figure 2.

Figure 2: Block Diagram of Matched Filter Detection

Matched filter is ready to perform expeditiously and optimally once a user operates at secondary sensing node will perform a coherent detection of the first signal. However, inside spectrum sensing to use the matched filter, the secondary sensing node should be synchronal to the first system and it should be ready to take out the first signal. Matched filter detection need less detection time. Once the knowledge of the commissioned user signal is understood to the Cognitive Radio user, Matched filter detection is sweet in detection of noise. There are some drawbacks of this system that are:

- It needs a previous data of each primary signal.
- CR would wish an avid receiver for each style of primary user.

The matched filter detection primarily based sensing is precisely a similar because the ancient matched filter detection technique deployed in digital receivers. Clearly for match filter primarily based spectrum sensing a whole data of the first user signal is needed (such because the modulation format rate, carrier frequency, pulse form, etc).

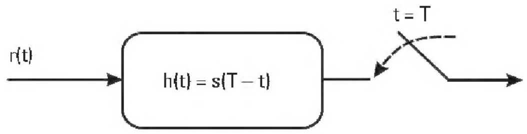

Figure 3: Matched Filter Based Spectrum Sensing and Detection of Primary Users

The matched filter detection technique could be a terribly well-treated topic in literature, and thus, we tend to simply gift the elemental results on matched filter detection during this section. Given a true transmit signal undulation s(t) outlined over $0 \leq t \leq T$ the corresponding matched filter increasing the signal to noise ratio at the output of the filter sampler is given by

$$h(t) = \begin{cases} s(T-t); \ 0 \leq t \leq T \\ \quad 0; \ elsewhere \end{cases}$$

Figure 3 depicts matched filter primarily based spectrum sensing methodology for primary user detection. Considering that an entire signal data of the first user signal is needed during this case the matched filter methodology isn't very suggested by the system designers to suit our purpose here unless once the entire signal data is understood to the secondary user. Then supported the take a look at datum $\xi(nT)$ at the output of the filter sampled each $t = nT$ seconds, the detector is given by

$$d(nT) = \begin{cases} 0; \ \xi(nT) < \lambda \\ 1; \ \xi(nT) \geq \lambda \end{cases}$$

The matched filter-based detector provides higher detection likelihood compared to the strategies exploitation the energy detector and therefore the cyclostationary feature based mostly detector; but as mentioned, it needs complete signal information and desires to perform the complete receiver operations (such as synchronization, reception, etc.) so as to discover the signal. Matched filter detection wants less detection time as a result of it needs solely O (1/SNR) samples to satisfy a given likelihood of detection constraint.

Cyclostationary Feature Based Detection

The feature detection technique exploits the statistical feature engineered into a primary signal. Generally, the ground noise and interference don't correlate to time or frequency domains. Hence, if the secondary user has statistical data concerning the correlation feature of the first signal, it will increase sensing accuracy. For example, the Gaussian minimum shift keying (GMSK) utilized in the Global System for Mobile Communications (GSM) network has inherent cyclostationarity, in order that the secondary user will effectively sightthe GSM signal by victimisation it. However, this feature detection will solely be applicable for few primary signals with such characteristics and needs a rise in price and quality for the time shift correlation method and frequency-domain transformation severally as shown in Figure 4.

Figure 4: Block Diagram of Cyclostationary Feature Based Detection

It exploits the regularity within the received primary signal to spot the presence of primary users (PU). The regularity is usually embedded in curved carriers, pulse trains, spreading code, hopping sequences or cyclic prefixes of the first signals. Attributable to the regularity, these cyclostationary signals exhibit the options of periodic statistics and spectral correlation, that isn't found in stationary noise and interference. Thus, cyclostationary feature detection is strong to noise uncertainties and performs higher than energy detection in low SNR regions. Although it needs a priori data of the signal characteristics, cyclostationary feature detection is capable of characteristic the cognitive radio transmissions from numerous styles of Primary User signals. This eliminates the synchronization demand of energy detection in cooperative sensing. Moreover, cognitive radio users might not beneeded to stay silent throughout cooperative sensing and so rising the general cognitive radio out turn. This technique has its own shortcomings due to its high process complexness and long sensing time. Attributable to these problems, this detection technique is a smaller amount common than energy detection in cooperative sensing.

RESULTS AND DISCUSSIONS

An extensive set of simulations are conducted victimization the system model as represented within the previous section victimizing MATLAB Simulink. The stress is to investigate the comparative performance of 2 spectrum sensing techniques. The performance metrics used for comparison embrace the brink and it's additionally analyzed victimisation the noise models of Gaussian, Rayleigh and Rician. The quantity of primary users thought of during this analysis is 2 and severally. The SNR of the channels is taken into account to be high in Rayleigh fading channel.

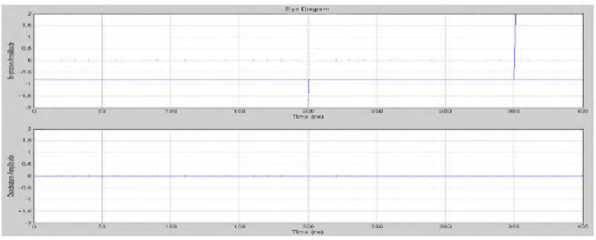

Figure 5: Simulink Output of Matched Filter Detection

The simulink output of the matched filter detection shown in Figure 5. which is shoot out from the eye diagram where it reveals the pulse duration and modulation of the system.

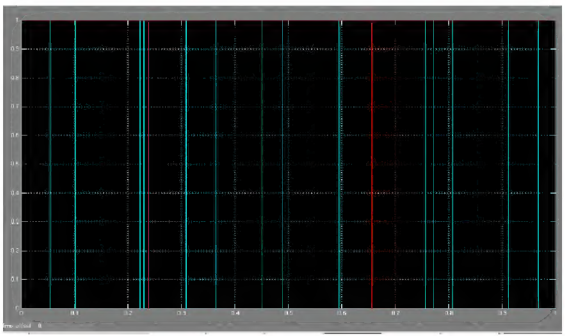

Figure 6: Rayleigh Noise Model

The Rayleigh noise model shown in Figure 6 implies that the primary users are detected, indicated in red coloured line and the noise level, indicated in blue coloured line. The performance is good as primary user detection is better.

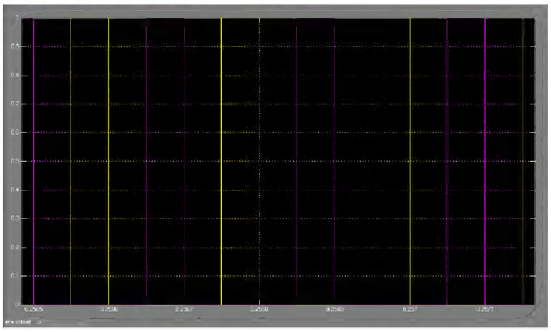

Figure 7: Gaussian Noise Model

The Gaussian noise model shown in Figure 7 implies that the primary users are detected, indicated in rose coloured line and the noise level, indicated in yellow coloured line. The performance is degraded as primary user detection is above he noise level. The Rician noise model shown in Figure 8 implies that the primary users are detected, indicated in green coloured line and the noise level, indicated in blue coloured line. The performance is degraded very badly as primary user detection is worse. As such, the three noise models are simulated to analyze the best suitable channel for the primary user detection even under high noise. The choice of choosing the spectrum sensing techniques of matched filter detection and cyclostationary feature based detection are that the sensing accuracy is to be high by building such a complex model where energy detection spectrum sensing which is easy to implement.

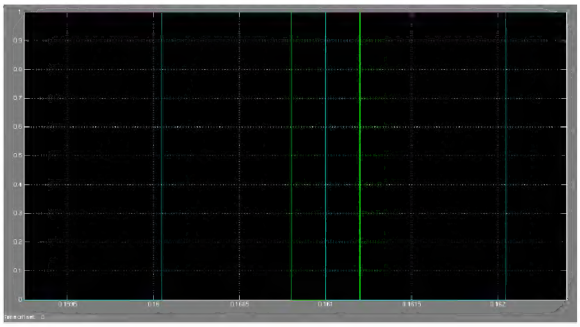

Figure 8: Rician Noise Model

CONCLUSIONS AND FUTURE SCOPE

The traditional methods of spectrum allocation were studied in the literature which includes subcarrier allocation, adaptive joint scheduling, multi-channel co-operative sensing and Peak to Average Power Ratio (PAPR). Also many other spectrum sensing techniques are available. Here, two methods of matched filter detection and cyclostationary feature based detection spectrum sensing are being compared under high noise and the performance of the system is analyzed using various noise models where the results are obtained.

This work can be extended for other channel detection, such as analysis of decision making using Fuzzy logic system, collaborative spectrum sensing for Multi-band Cognitive Radio systems. More over algorithms can be implemented to identify the severity of the channels in the spectrum also.

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